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Patent Application

of

GUISEPPE ZEOLLA

for

# COOLING DEVICE

## Field of the Invention

The present invention relates to a cooling device comprising a cooling unit through which a fluid to be cooled, in particular hydraulic oil, can flow. The unit has a device housing and at least one filter unit for filtration of the fluid.

## Background of the Invention

These cooling devices can be used for a plurality of applications, and are available in the most varied embodiments. The cooling device systems freely available on the market to date however all have either a filter unit flanged to the cooling unit, or tank units connected to the cooling units with the respective tank unit holding the filter element. The known cooling devices are therefore generally formed of several components. The actual cooling unit can be connected by the corresponding piping to the actual filter unit as the cooling device is being produced. Misconnections can then occur in the piping, and consequently malfunction sources occur in the installation of the known cooling devices. Furthermore, the known cooling device solutions are structurally large due to the diversity of their parts and accordingly heavy. This characteristic is especially disadvantageous for mobile use.

In the known cooling device according to WO 01/65123 A1, the cooling unit and the filter unit are combined with each other in one piece. The filter unit together with the cooling unit is

located in a device housing, avoiding a multipiece construction. The known cooling device can be made much more compact and light with the same performance. By integrating the cooling unit and filter unit in one device housing, the conventional piping can be eliminated, with malfunction sources being precluded. The disadvantage in this known solution is however that in the replacement process of a used filter element by a new one, the device housing of the cooling unit must be opened. This opening is accompanied by a corresponding expenditure of time. When the used filter element is removed from the device housing of the cooling unit, fluid components also end up on the outside. This placement can lead to contamination with the corresponding post-cleaning process.

CH 533 246 discloses a device for storing, filtering, and cooling of a fluid medium, especially for a hydraulic system, with a fluid container. In a vertical through opening surrounded by the jacket-shaped container above the fan, a deflection housing holds a filter through which flow takes place from top to bottom and forms an annular cooling channel with the container and through which a stream of the filtered fluid flows from bottom to top. The connecting lines emerging from its top end are connected to the container such that the fluid flow, which is now directed down, remains in the action region of the cooling channel. These connecting lines together with a connection for the oil return from the hydraulic system form arms with which the deflection housing can be supported and mounted on the top of the container.

Summary of the Invention

An object of the present invention is to provide an improved cooling device retaining conventional advantages, being compact and light-weight in design, eliminating complex piping between the cooling unit and filter unit, and preventing contamination in the replacement of the respective filter element.

This object is basically achieved by a cooling device where the device housing of the cooling unit has at least one overhanging support arm. The filter unit is connected to the cooling unit via that support arm to carry fluid from the cooling unit to the filter unit and vice versa. The filter unit, with the filter element, is located outside of the actual device housing of the cooling unit,

and still integrally connected by the support arm to the cooling housing. With the support arm solution of the present invention, it is possible to separate the filter unit with the respective filter element from the cooling unit without in the process having to open the device housing of the cooling unit. Since the cooling unit remains on site, for example, on a hydraulic machine, the filter unit can be moved with the respective filter element for a replacement process to a suitable location, where the contamination arising in the process of replacing the filter element is of no concern. The unused and newly inserted filter element is then moved back onto the support arm by the filter unit. The cooling device together with the filtering process can then be started up again.

Since the support arm can be a one-piece component of the cooling unit with its device housing, complex piping together with the pertinent sealing systems is omitted and the fluid paths in particular can be kept short. This arrangement is favorable for the entire cooling device in terms of energy balance. Although the filter housing itself is no longer directly an integral component of the device housing of the cooling unit, but is located externally by the support arm, the total structural weight is reduced. In addition to a compact construction, the cooling device of the present invention is also economical to produce and, as already indicated, economical to maintain, since complex after-cleaning due to overflowing hydraulic medium on the cooling device at any rate is not necessary.

In one preferred embodiment of the cooling device of the present invention, the filter unit is located in the flow direction of the fluid, downstream from the cooling unit, so that the filter element is thermally protected. By preference, the cooling unit is made as a plate-shaped finned radiator. This plate configuration is especially advantageous when the installation spaces are kept flat. Preferably, the device housing is composed of sheet metal parts, and due to this modular design the production costs can be cut. It is also possible to make the finned radiator as a casting, especially as an aluminum diecasting.

By using suitable bypass valves, the cooling device can be adapted to the most varied volumetric flows with the result that the cooling device can be used in a wide range of applications with different orders of magnitude of fluid volumetric flows, without the need for structural

changes. Moreover, it has proven especially environmentally friendly to make the respective filter element out of materials which can be completely incinerated, so that residue-free disposal is for the most part achieved.

To improve the cooling performance, a motor-fan unit which increases the required air throughput in the finned radiator and which thus leads to improved radiator results is connected to the cooling unit, especially to its front side.

If in the region of the connecting cover on the support arm a fouling indicator is mounted, information is provided regarding the degree of fouling of the filter element. In the clogged or almost clogged state and therefore fouled state, the filter element is to be replaced by a respective new one. This replacement takes place quickly and in a manner easy to install by loosening a screw connection between the filter housing and the cover part securely located on the support arm. In this way, stationary installation of the cooling device on a hydraulic unit can also be achieved in the mobile domain. Replacement of the respective filter element can take place at some other suitable location, where overflowing fluid contamination is of no concern.

Other objects, advantages and salient features of the present invention will become apparent from the following detailed description, which, taken in conjunction with the annexed drawings, discloses a preferred embodiment of the present invention.

Brief Description of the Drawings

Referring to the drawings which form a part of this disclosure:

FIG. 1 is a schematic, not to scale, perspective view of the front of a cooling device according to one embodiment of the present invention;

FIG. 2 is a perspective view of the back of the cooling device of FIG. 1;

FIGS. 3 and 4 are partial, front, elevational views in section illustrating the fluid guidance within the filter element over the assignable support arm in the cooling device of FIG. 1;

FIGS. 5, 6, and 7 are partial, perspective views of various bypass valve solutions, to the extent they are used in the cooling device of FIG. 1; and

FIG. 8 is a hydraulic circuit diagram showing the basic structure of the overall cooling device of FIG. 1.

Detailed Description of the Invention

The cooling device has a cooling unit 10 through which a fluid to be cooled, in particular hydraulic oil, can flow, and a filter unit 12 for filtration of this fluid. As FIGS. 1 to 4 show in particular, the cooling unit 10 and the filter unit 12 are integrally connected to each other via a support arm 14 with an internal fluid guide 16. The support arm 14 preferably is an integral component of the device housing 18 of the cooling unit 10. According to the embodiment shown in the drawings, the filter unit 12 is located in the flow direction of the fluid (hydraulic medium) downstream from the cooling unit 10.

As shown in FIG. 2, the cooling unit 10 is made as a plate-shaped, finned radiator. To guide the cooling air, the plate radiator has fins 20 folded up in a zig-zag shape. Between the fins, the fins border fluid routing channels 22 are used to transport the fluid to be cooled. The direction of air guidance through the cooling unit 10 runs perpendicular to the plane of FIGS. 1 and 2, with the actual fluid transport direction extending transversely thereto, that is, in the plane of the figures. The stacked fluid routing channels 22 discharge on either side into the fluid collecting spaces 24, 26. These collecting spaces 24, 26 form elongated fluid-carrying spaces which extend along the two longitudinal sides of the cooling unit 10. The structure of these finned radiators is in general conventional, so that it is not described in detail, but is only described to the extent necessary for explanation of the structure of the present invention. The device housing 18 in this embodiment is composed of individual sheet metal parts. It is also possible to produce it as an aluminum casting.

If the device housing 18 is composed of sheet metal parts, it is held together via the corresponding weld connections (not shown).

The filter unit 12 on the outer peripheral side is formed essentially cylindrical. Fluid supply 28 (FIG. 3) takes place in the upper edge area of the filter element 30 held in a pot-shaped filter housing 32 of the filter unit 12. The direction of flow of dirty fluid through the filter element 30 is from outside to inside. Fluid removal or discharge 34 takes place by the interior of the filter element 30 (FIG. 4). The actual filter element 30 can be formed of conventional filtration materials, for example, as a pleated hollow cylindrical filter mat surrounding a middle support tube received in the pot-shaped filter housing 32 from the top. By filtering out dirt from the fluid (hydraulic medium) via the filter element 30, it is ensured that the cleaned fluid cannot form deposits in the connected hydraulic unit in such a way that operation of the entire hydraulic system is compromised.

As is to be seen in particular in FIGS. 3 and 4 and viewed in the direction of FIGS. 3 and 4 from left to right, cooled fluid medium flows into the shaft-like fluid collecting space 24. Fluid collected in space 24 flows via the internal fluid guide 16 of the support arm 14 to the filter unit 12. These inflow conditions are shown in FIG. 3. The fluid which has been cleaned by the filter element 30 is relayed via the discharge 34 and in turn via the internal fluid guide 16 of the support arm 14 into a collecting tube 36 within the collecting space 24. Fluid guidance of the supply 28 and discharge 34 are located separately and next to each other. The pot-like filter housing 32 on its upper end has an external thread 38 which can be fixed or coupled to the internal thread section 40 of a cover part 42. This cover part 42 extends from the outside over the upper area of the filter housing 32 and is an integral component of the support arm 14. In the middle, the cover part 42 is penetrated by a fouling indicator 44 providing information about the state of fouling of the filter element 30. These fouling indicators 44 are conventional in the field of hydraulics so that they are not described in detailed. The cooling unit 10 on its one front side is provided with a motor-fan unit 46 which improves the air throughput between the free intermediate spaces of the fins 20 of the cooling unit 10.

As FIG. 5 shows, on the bottom of the collecting pipe 36, a combined replenishing and check valve 48. Valve 48 is spring-loaded as a check valve in one direction allowing fluid routing to the tank. In this way, valve 48 forms protection against an overpressure. In the other direction, valve 48 serves as a replenishing valve allowing the fluid to be able to subsequently flow into the collecting pipe 36 coming from the tank. For this replenishment function, a head part 50 lifts off a contact plate 52 having a fluid guide in the middle and being held by the compression spring 54 in its closed position, as shown in FIG. 5.

In the same region as the combined replenishing and check valve 48, another spring-loaded check valve 56 is located in the fluid supply 28 in the fluid direction upstream from the filter element 30, and protects the fluid cooling circuit to the tank T. As FIG. 7 shows, on the side opposite the cooling unit 10 and on the bottom end of the fluid collecting space 26, a thermobypass valve 58 is provided internally with an expansion element 60. These thermobypass valves 58 are conventional, so that their structure is not described in detail. The thermobypass valve 58 is used at low fluid temperatures to directly enable fluid supply to bypass the cooling unit 10 and to flow to the filter unit 12, specifically by the bypass channels 62 extending parallel to the fins 20 and located subjacent to the fins. If at this point the fluid heats up due to operation of the hydraulic system (not shown), the expansion element 60 expands as heating increases to close the bypass channels 62 so that with increasing heating of the fluid most of it is cooled by the fluid routing channels 22 of the cooling unit 10 and supplied to the filter unit 12 with the medium being cooled in this way and flowing into the longitudinal shaft-shaped fluid collecting space 24.

For suitable fluid guidance, the cooling unit 10 in the fluid collecting spaces 24 and 26 has the corresponding fluid connection sites. Connection sites for connection of measuring units can also be provided, for example, for detecting the temperature of the hydraulic medium. Viewed in the direction of FIG. 1, the shaft-like collecting space 26 at top left has at least one connection site 64 for the dirty fluid to be cooled. Subjacent thereto (see FIG. 2) there is a connection site 66 for connection of a temperature detection unit (not shown). On the opposite side, the longitudinal shaft 24 has two return lines 68 to remove cooled fluid before running through the filter unit 12. These amounts of fluid can be used for special tasks which are not

further specified for a hydraulic system. The subjacent connection sites 70 are used to connect a hydraulic suction pump (not shown) ensuring hydraulic circulation for the cooling unit 10 and the filter unit 12. The respective connection sites 70 as the supply of a suction pump (not shown) are located in the fluid direction downstream from the filter element 12 in the collecting space 24. The hydraulic circuit diagram illustrated in FIG. 8 clearly shows the aforementioned fluid guides and circuits, as well as the essential components of the cooling device.

While one embodiment has been chosen to illustrate the invention, it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.

What is claimed is: